Renewable Energy, Natural Gas, and Other Hybrid Systems: Activities within EERE Office of Power Technologies

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August 7, 2001
Morgantown, West Virginia
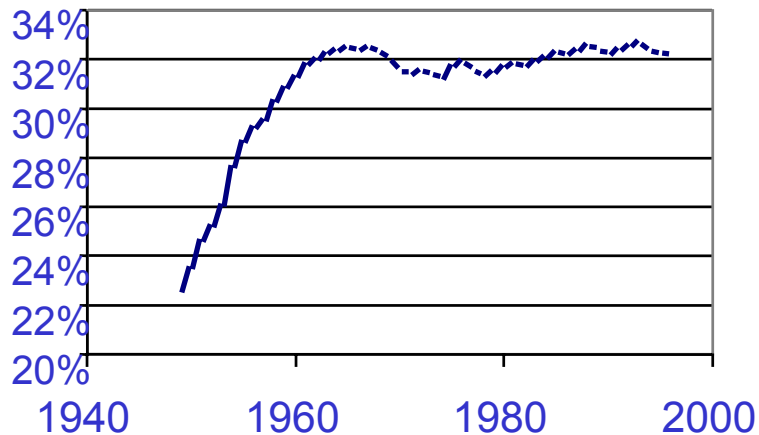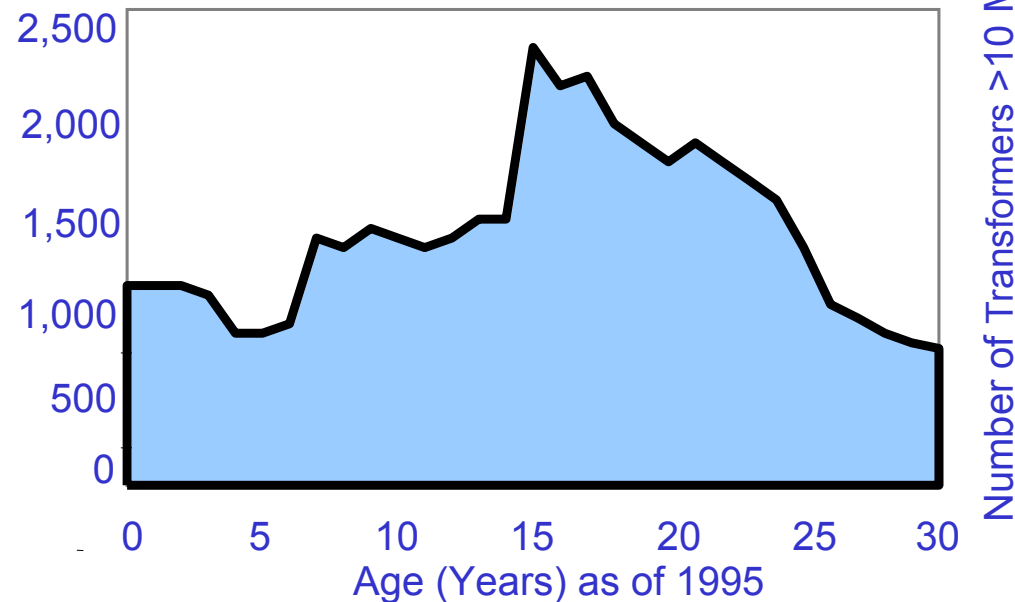
Is This Our Energy Future?

Aging Power Infrastructure

Fossil Electric Generation Efficiency (at plant, W/O T&D)

Installed Transformer Banks in the U.S.

Number of Transformers >10 MVA

Age (Years) as of 1995

Source: EIA, Annual Energy Review 1999
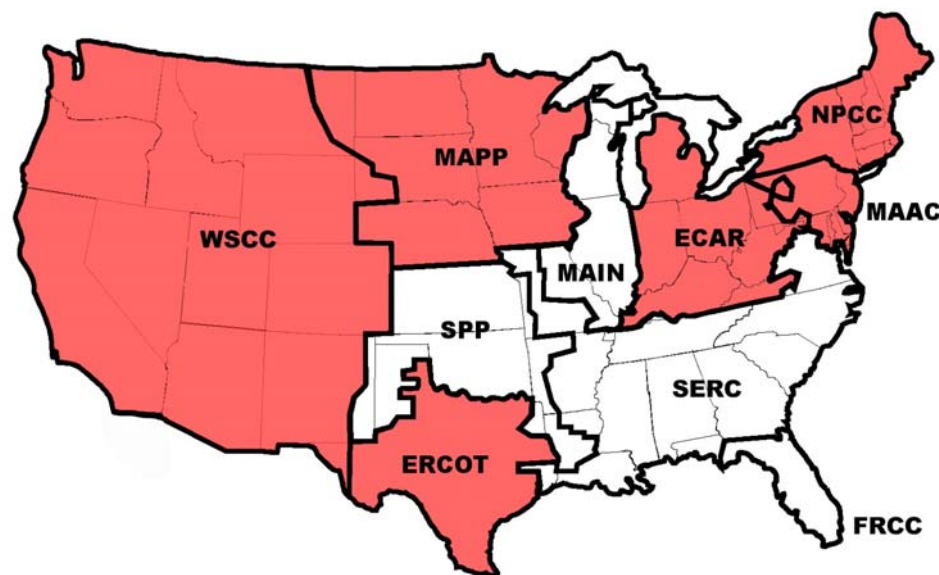
Source: Waukesha Electric Systems 1997

Electric Power Constraints

"If the energy infrastructure of this country is inadequate or in some way excessively costly, it will undermine economic growth, and is therefore a major issue that must be addressed." *Alan Greenspan, January 26, 2001*

2009 Projections

Areas with Capacity Margins < 10 percent

Source: North American Electricity Reliability Council, 2000

Power Outages & Reliability

Regions Forecasting Capacity Margins < 10% in 2009

	Affected NERC Regions (WSCC, MAPP, ERCOT, ECAR, NPCC, and MAAC)	U.S. Total	% of U.S. Total
Number of Customers (1999)	~81 million	125.2 million	~65%
Electric Sales (million kWh in 1999)	~1,959,734	3,235,899	~60%
Revenue from Electric Sales (1999)	~$137 billion	$215.5 billion	~63%

Source: U.S. DOE, Energy Information Administration, Electric Power Annual 1999, Volume II, October 2000.

"The Transition"

In the delivery of electric power…

Yesterday

Today

The Analog Age

The "Digital Age"

"3 nines"

Electro-mechanical devices

Central power business model – "one size fits all"

"6 nines"

Online, inter-connected, integrated

Distributed energy model – customized solutions
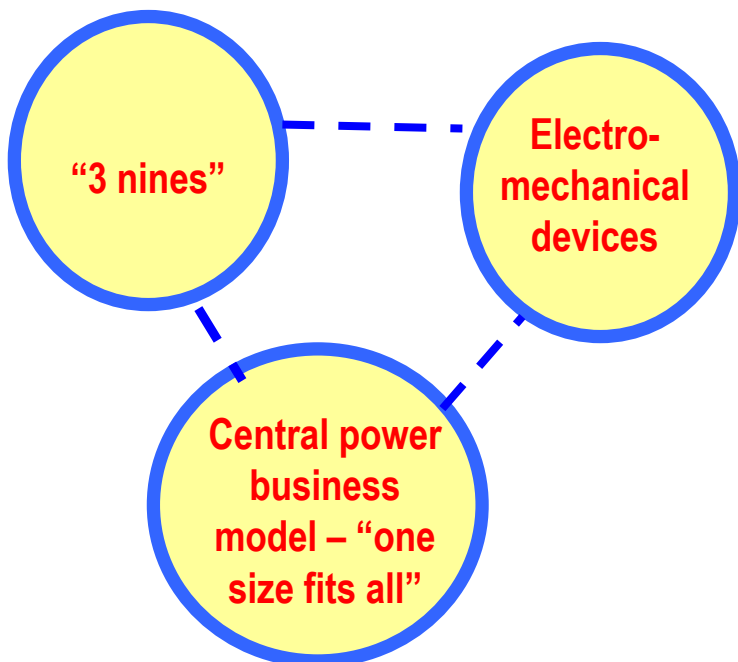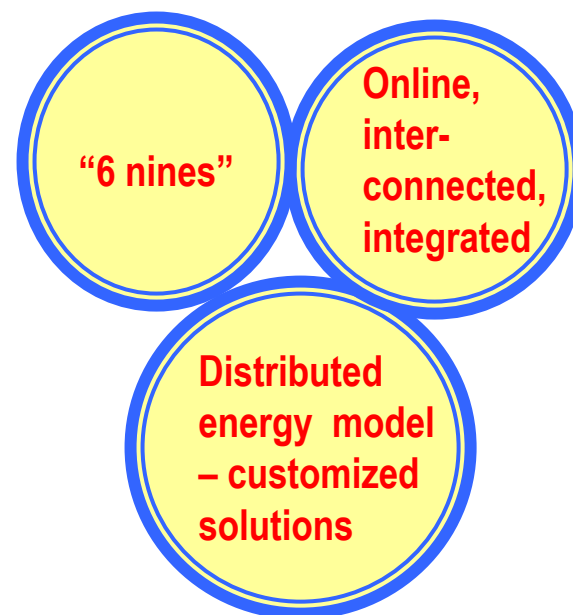
"Window of Opportunity"

A confluence of events...

2000

2010

- **New National Energy Plan**

- **H_2 Re-authorization**

- **Hydro Relicensing**

- **Utility Restructuring**

- **Aging T&D Infrastructure**

- **Generation Capacity Additions**

- **Transition to the "Digital Age"**

President Bush's National Energy Plan

The comprehensive plan contains more than 100 recommendations

- **42 will help modernize and increase conservation, protect our environment and help our communities.**

- **35 will help diversify our supply of clean, affordable energy and modernize our antiquated infrastructure.**

- **25 will help the U.S. strengthen its global alliances and enhance national energy security.**

National Energy Policy

Report of the
National Energy Policy Development Group

May 2001

Federal Legislation

H.R. 4, SAFE Act

- **Passed by U.S. House of Representatives on August 2**
- **Supported by President Bush**
- **Includes specific language guiding the Secretary of Energy to develop a distributed power hybrid systems strategy and reauthorizes the Hydrogen Energy Act**

Congressional findings: "Our ability to take advantage of our renewable, indigenous resources in a cost-effective manner can be greatly advanced through…distributed power hybrid systems"

(Title I, Subtitle B, section 2121-2123)

Portfolio of Technologies

Solar Buildings

Energy Storage

Advanced Turbines

Photovoltaics

Microturbines

Thermally Activated

Hydrogen

Hydropower

Superconducting Cable

Biomass

Combined Heat and Power

Wind
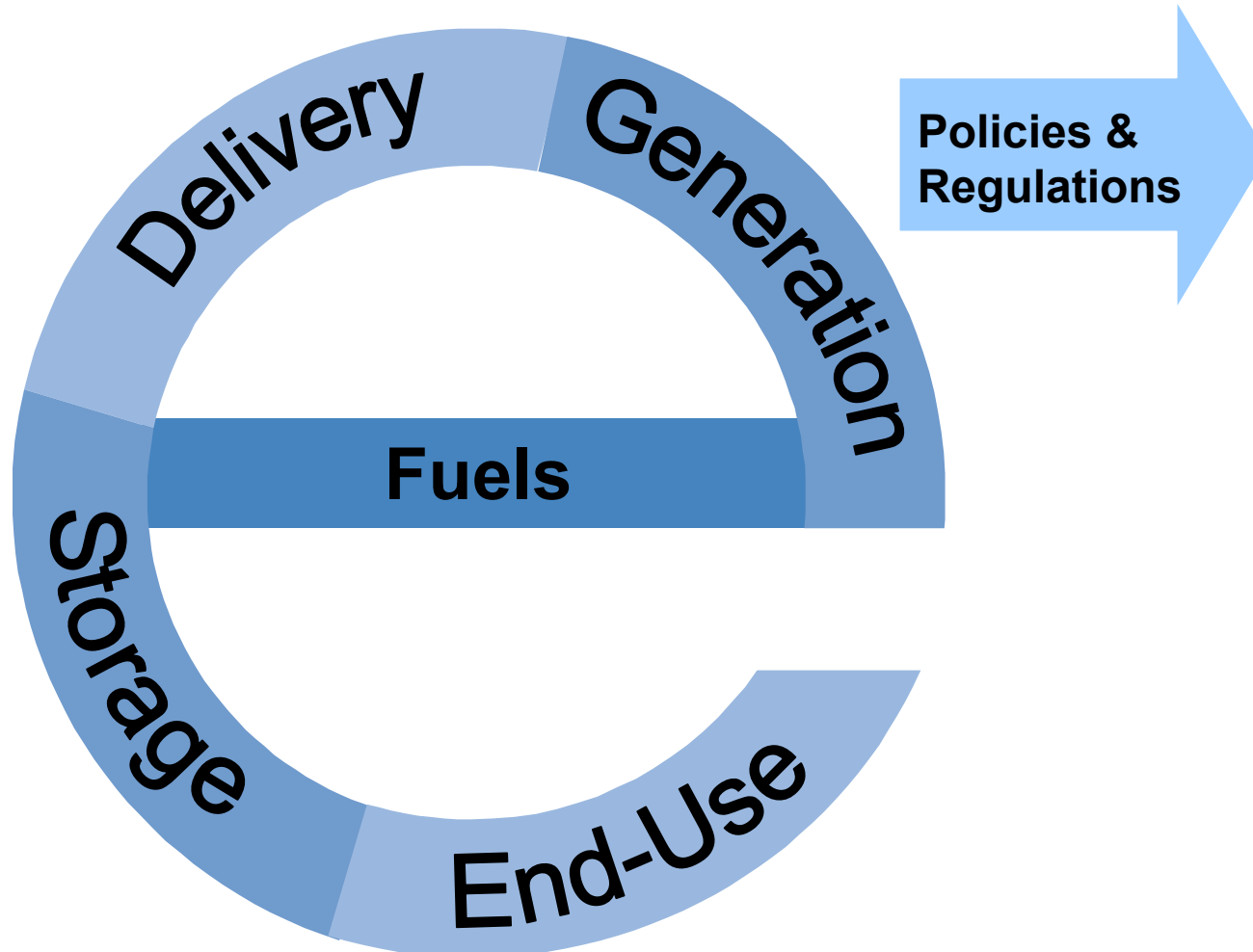
T&D

Geothermal

OPT Mission

To lead the national effort to develop and support clean, competitive, reliable renewable energy, natural gas, and power delivery technologies for the 21st century.

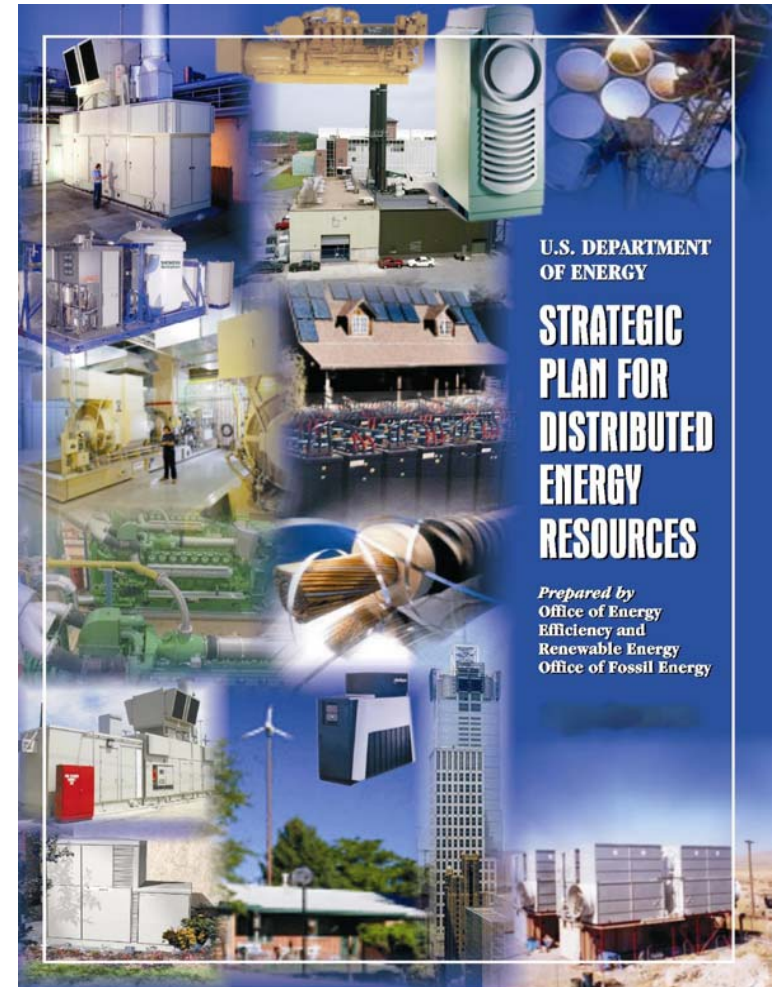# OPT Energy Value Chain

Office of Power Technologies

Delivery

Generation

Fuels

Storage

End-Use

Policies & Regulations

DOE Coordination

DER Strategic Plan
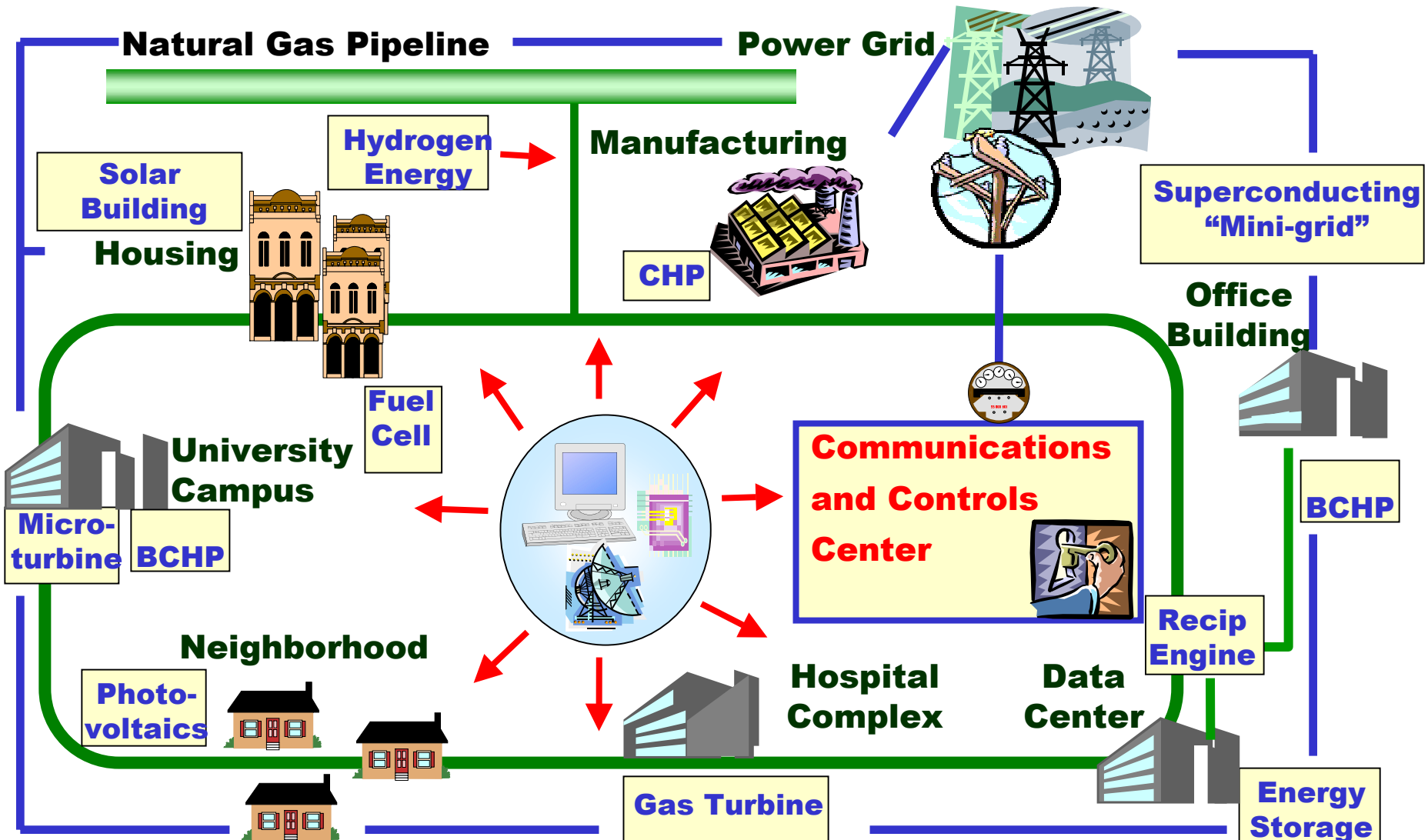
- **Vision 2020:** *The U.S. will have the cleanest and most efficient and reliable energy system in the world by maximizing the use of affordable DER.*

- **Goal 2012:** *DER will achieve 20%+ of new capacity additions.*

U.S. DEPARTMENT OF ENERGY

STRATEGIC PLAN FOR DISTRIBUTED ENERGY RESOURCES

Prepared by
Office of Energy Efficiency and Renewable Energy
Office of Fossil Energy

Distributed Energy System

Natural Gas Pipeline ——— **Power Grid**

Solar Building

Hydrogen Energy

Manufacturing

Superconducting "Mini-grid"

Housing

CHP

Office Building

Fuel Cell

University Campus

Micro-turbine   **BCHP**

Communications and Controls Center

BCHP

Neighborhood

Photo-voltaics

Recip Engine

Hospital Complex   **Data Center**

Gas Turbine

Energy Storage

Hybrid Portfolio

Microturbine/Chiller

Photovoltaics/Hydrogen Electrolysis

Solar/Wind

Microturbine/Storage

Wind/Engine

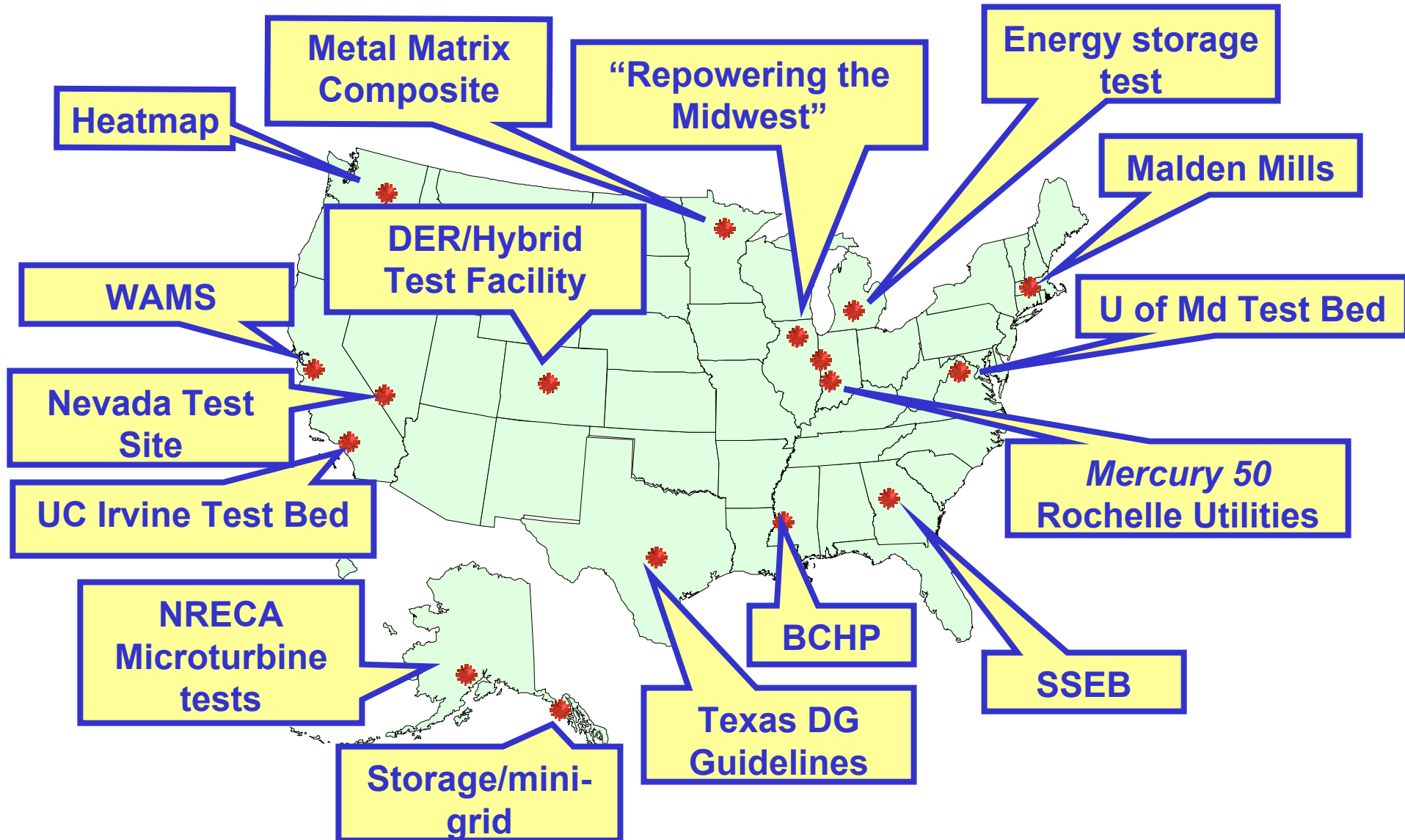# Integrated CHP Installation at the University of Maryland

Windows Thermal Pane

Weather Station

Roofing Materials

Advanced Building Materials, Insulation

Foundation

Ventilation
- -Ducts
- -Piping
- -Fans
- -Blowers

Low Voltage Grid

Controls DG

Instrumentation

Power

Heating/Cooling

Humidity Control

Comfort Indoor Air Quality

Storage

Reject

Activities

Heatmap

Metal Matrix Composite

"Repowering the Midwest"

Energy storage test

Malden Mills

DER/Hybrid Test Facility

WAMS

U of Md Test Bed

Nevada Test Site

UC Irvine Test Bed

Mercury 50 Rochelle Utilities

NRECA Microturbine tests

BCHP

SSEB

Storage/mini-grid

Texas DG Guidelines

Value Propositions

Renewables

Storage

Hybrid System Value Propositions:

Low Emissions

Efficiency

Reliability

Low Cost

The whole is greater than the sum of its parts.

Fossil Fuel Generators

Power Electronics

Value Proposition – Low Emissions

Hybrid systems can be designed for the most effective use of renewables.

Microturbines have very low emissions.

Value Proposition - Reliability

Achieving higher reliability can be accomplished with redundant technologies and/or energy storage. Some hybrid systems typically include both, which can simultaneously improve the *quality* and *availability* of power.

The PV/Propane/Battery hybrid at Dangling Rope Marina significantly increased the reliability of the power system.

Value Proposition - Low Cost

Hybrid systems can be designed to achieve desired attributes at the lowest possible cost, which is the key to market acceptance.

By cutting diesel fuel consumption, the King Cove, Alaska run-of-the-river hydroelectric plant and battery system reduced electricity costs for the town's residents.
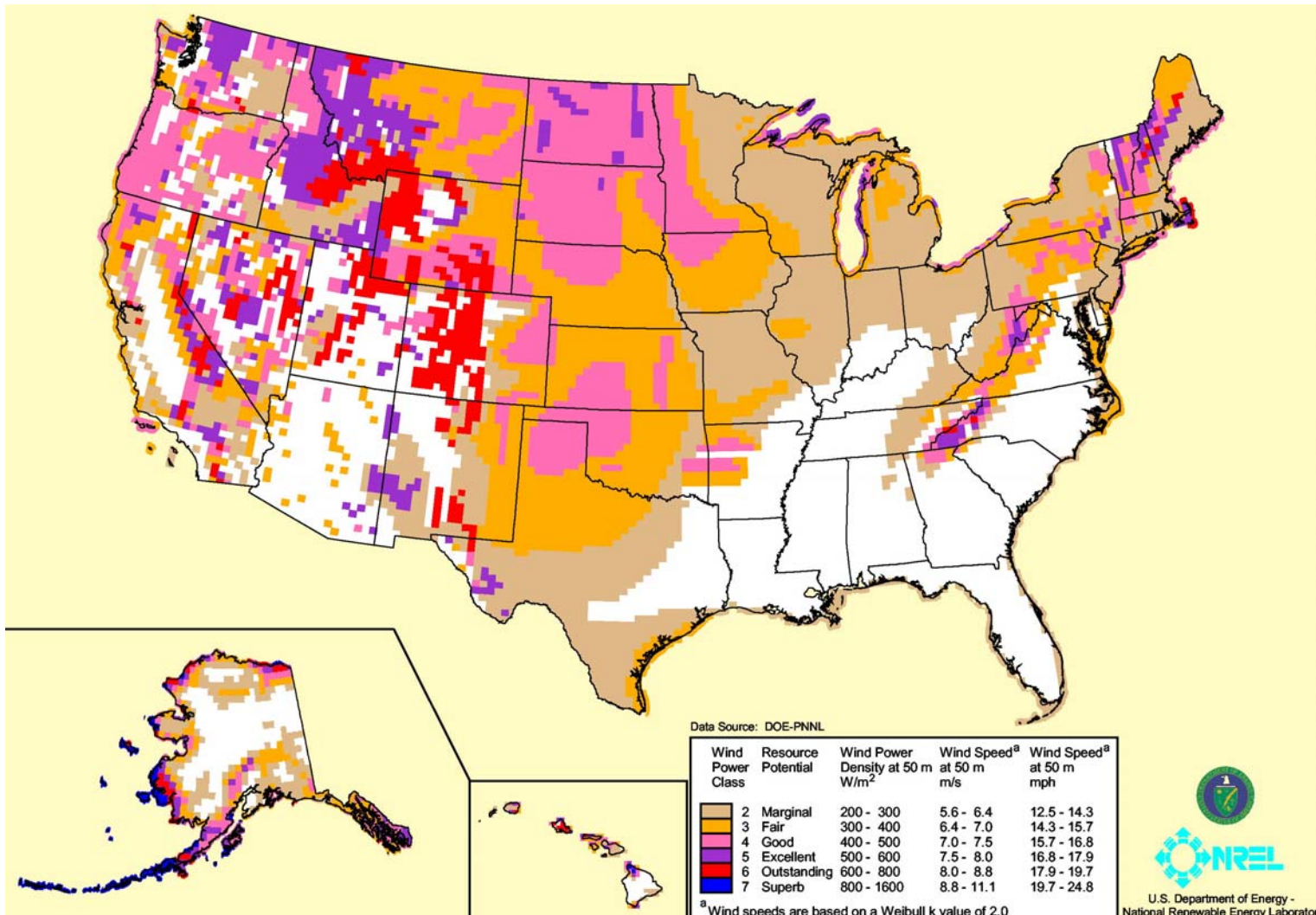
Hybrids as Part of DER Solution

- **Addresses today's energy needs**

- **Modular systems serve onsite requirements**

- **Greater choices foster greater competition**

- **Opportunities for greater reliability**

- **Flexibility**

- **Resource and System Optimization**

Wind Resource

Data Source: DOE-PNNL

Wind Power Class	Resource Potential	Wind Power Density at 50 m W/m^2	Wind Speed[a] at 50 m m/s	Wind Speed[a] at 50 m mph
2	Marginal	200 - 300	5.6 - 6.4	12.5 - 14.3
3	Fair	300 - 400	6.4 - 7.0	14.3 - 15.7
4	Good	400 - 500	7.0 - 7.5	15.7 - 16.8
5	Excellent	500 - 600	7.5 - 8.0	16.8 - 17.9
6	Outstanding	600 - 800	8.0 - 8.8	17.9 - 19.7
7	Superb	800 - 1600	8.8 - 11.1	19.7 - 24.8

[a] Wind speeds are based on a Weibull k value of 2.0

U.S. Department of Energy -
National Renewable Energy Laboratory

Websites

- **www.eren.doe.gov/power**
- **www.eren.doe.gov/der**
- **www.eren.doe.gov/distributedpower**